

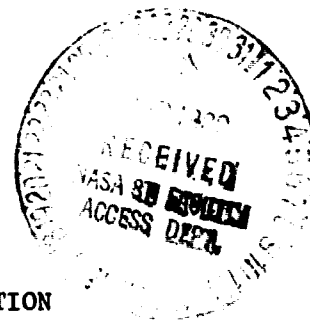
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PRINCIPLES FOR CLASSIFICATION OF WORK LOAD FOR WOMEN

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and V. A. Buzunov

Translation of "O printsipakh klassifikatsii tyazhesti rabot dlya
zhenshchin", Gigiyena truda i professional'nyye zabolevaniya, No. 7, July,
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16. Abstract <p>In an attempt to develop guidelines for classification by degree of intensity of various kinds of physical work performed by women, the effects of different work loads on women as compared to men were studied under industrial and experimental conditions, including responses of the cardiovascular and respiratory systems to specified physical exercises of increasing intensity. Physiological criteria for assessing female labor in terms of intensity are proposed.</p>			
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PRINCIPLES FOR CLASSIFICATION OF WORK LOAD FOR WOMEN

by

A. O. Navakatikyan, A. P. Okhrimenko, A. N. Karakashyan,
and V. A. Buzunov*

In the works of Soviet and foreign authors (T. G. Gromova et al.; N. I. Kar- /10**
pova et al.; Z. V. Volkova et al.; Muller) there are indications of a more pro-
nounced reaction of the cardiovascular, respiratory, neural-muscular and other
systems in the female organism as compared to the males for the same type of
production load. G. Leman notes that the boundary amounts of energy outlays
used for evaluating the degree of labor load (intensity of muscle load) for
women must be reduced by 15-20%, without, however, giving a clear argument for
this reduction.

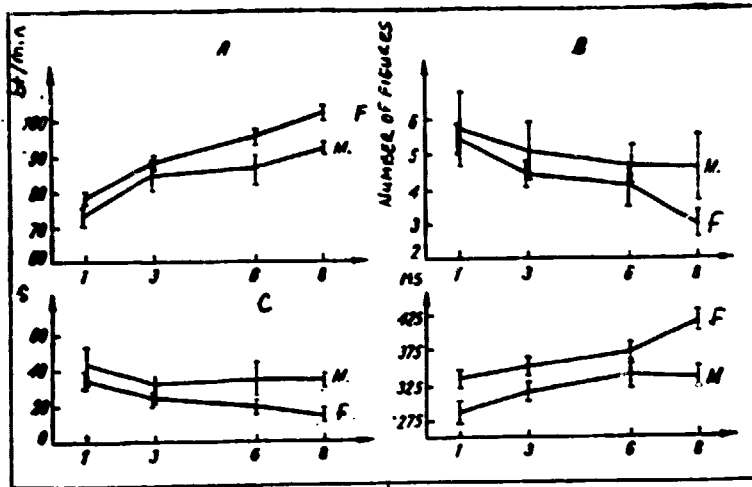
The purpose of this study was to develop the principles for classifying
work of women according to the load.

Under production conditions at eight thermoelectric power plants during
a work shift (for 1, 3, 6 and 8 hours) a study was made on machinist-inspectors
of turbines (20 men and 66 women) for the state of the cardiovascular system,
higher nervous activity, neuromuscular apparatus. All the subjects were in age
from 25 to 40 with length of service up to 15 years.

The work of the machinist-inspector is characterized by considerable
physical stress linked to the frequent movements in the work zone (up to 10-15 /11
km in a shift), rotation of valves and dampers. The work site of the inspector
is not stationary. There are 154 instruments, 165 light switches, and 22 knobs

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** Numbers in margin indicate pagination in original foreign text.



Change in Physiological Indices in Men and Women in Dynamics of Work Day
On x-axis--hours of work: A--frequency of cardiac contractions; B--volume of active memory; C--endurance of muscles for standard static force; D--velocity of simple visual-motor reaction.

in the attention sphere of the machinist-inspector. The density of the work day is 97-98%. Rounds of the equipment and cleaning of the work zone comprise 25% of the work time, work to regulate the switchings of the equipment--31.2%, observation of the work of the aggregates--18.6%. The energy outlays for the fulfillment of typical working operations fluctuate from 1.6 to 6.1 kcal/min, comprising during start-up and stopping of the equipment 5.5-6.1 kcal/min, making rounds of the equipment from 0 to mark 36 4.8-5.2 kcal/min, cleaning the work zone 3.4-3.5 kcal/min, and observation of the operation of the aggregates 1.5-1.8 kcal/min. The labor process also requires considerable stress on vision, memory and attention.

In the work process studies were made on the pulse rate, arterial pressure and electrocardiogram. Computations determined the hemodynamic indices. In the dynamics of the work day observations were made of the state of the active memory, concentration and distribution of attention (tabular tests), latent periods of conditioned-motor reflexes, and the muscle strength and resistance of the muscles to the standard static force were determined. With the aid of the method of indirect calorimetry the energy outlays were established for typical working operations, as well as the total energy outlays for a shift. Timing observations were made.

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In accordance with the method instructions developed by the International Biological Program velo-ergometry was conducted. Loads were suggested of 300, 600, 900, 1100 and 1300 kgm/min. to a state corresponding to the maximum oxygen consumption (VO_{2max}). The state of external respiration was studied from the following indices: respiratory volume, respiration rate, per-minute respiration volume, oxygen consumption, and coefficient of oxygen use. The frequency of cardiac contractions was recorded.

The comparative characteristics of the reaction of women and men machinist-inspectors of turbines to the fulfillment of the same type of production load indicate the greater stress of the studied functional systems of the female organism (see figure).

The data obtained in experimental conditions with the fulfillment of the same load --300 kgm/min (close to the production) agree with the described results (table 1). Consequently, the execution of the same type of physical loads with respect to amount under identical conditions occurs in women with greater stress of the energy exchange and cardiorespiratory system.

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A study of the functional potentialities of the female organism by fulfillment of work linked to a high degree of physical stress made it possible to establish that the maximum aerobic performance capacity with respect to the maximum oxygen consumption in women corresponded to VO_{2max} 1816-119 ml/min (see table 1). The amount VO_{2max} was attained by women with a load of 900 kgm/min. The energy outlays were 8.8 kcal/min, the coefficient of oxygen use (CO_2U)-- 41.2 ± 2.6 ml. In men the maximum aerobic performance capacity was reached during fulfillment of loads 1300 kgm/min, oxygen consumption here was 2620 ± 134 ml/min, energy outlays 12.6 kcal/min, CO_2U 67.2 ± 3.6 ml. The submaximum for women was the load 600 kgm/min, for men 1100 kgm/min. Oxygen consumption during the fulfillment of these loads was roughly 70-80% of its maximum amount. One should note first of all the difference in the magnitude of the submaximum load itself--in women it is on the average 54.5% of the analogous load in men. The fulfillment of these loads by women occurs with lower values of oxygen consumption (by 14.4%) and pulse rate (by 16.1%). The maximum aerobic performance capacity in women is by 30.8% lower. Here under conditions of the same pulmonary ventilation in women the oxygen consumption is by 30.7% lower, the frequency of cardiac contractions--by 5.1%, and the CO_2U --by 38.7% and energy outlays by 30.3%.

TABLE 1
LEVEL OF AUTONOMIC FUNCTIONS IN WOMEN AND MEN ENGAGED IN PHYSICAL LABOR

Load	Sex	Amount of load, kgm/min.	Index						
			RV, ml	f, cycle/min.	PVR, l/min	VO ₂ max, ml/min	CO ₂ U, ml	CRR, bt/mjn	E, kcal/min
300kgm/min	F	300	862±28	24.9±1.0	23.2±2.2	980±21	45.3±0.45	113±3.5	4.7
	M	300	913±43	16.0±0.8	13.8±0.7	839±30	59.3±4.2	90±4.0	4.0
	Δ%	0.0	-5.5	60	67	17.0	-23.6	12.6	17.5
Submaximum	F	600	1110±139	25.3±3.5	26.6±0.9	1531±58	58.6±4.4	133±4.2	7.6
	M	1100	1855±59	17.0±1.3	31.7±1.7	1840±87	59.0±4.3	150±6.0	8.9
	Δ%	-45.5	-40.2	-47.2	-16.1	-14.2	-0.6	-11.4	-14.7
Maximum	F	900	1287±42	29.3±2.0	40.3±1.2	1816±119	41.2±2.6	182±3.1	8.8
	M	1300	2000±106	20.0±1.5	40.4±1.5	2630±134	67.2±3.6	160±3.0	12.6
	Δ%	-30.8	-35.7	46.5	0.75	-30.7	-38.7	-5.1	-30.3

Note. RV--respiratory volume; f--frequency of respiration; E--energy outlays; PVR--per-minute respiration volume; CRR--cardiac contraction rate

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The findings make it possible to speak of the lower functional potentialities of the female organism as compared to the male to fulfill a considerable physical load. According to the data of Astrand the maximum aerobic performance capacity in women is 70-75% of the amount of this index in men. V. L. Karman et al., in studying the level of physical performance capacity with pulse 170 bt/min (PWC_{170}) came to the conclusion that it was 62.3% in untrained women, 70.1-76.1% in women athletes of this index in men.

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In approaching a classification of the labor load on women it is necessary to consider the data obtained in production and in experiments with the fulfillment not only of a load of 300 kgm/min. If one is guided only by them then it is sufficient to reduce for women the boundary physiological indices by 15-17% in order to guarantee a degree of stress of the physiological functions that is the same as the men's. However in that case the stress of the latter will be the same only for absolute values. The results obtained with the maximum load demonstrate that the limit of functional potentialities in women is lower (for energy outlays and VO_{2max} --the adopted criteria of physiological performance capacity--by 30%), while physiologically the cost is determined by the amounts of shift that are correspondingly greater than in men. This circumstance was for us the basis in developing the physiological criteria for the labor load of women. Based on this approach and the experimental results energy outlays were computed for the work of different categories of load. As is apparent from table 2 the boundary conditions we suggested for the amounts of energy outlays for the separation of the class of labor load for women are 30% lower than the labor of men, but in both groups comprise the same percentage of the VO_{2max} . Here the fulfillment of dynamic muscle work of the same class of load by men and women induces a change in pulse that is close in magnitude (in percentages of the maximum possible). The loads of the average degree of heaviness (II) are accompanied by cardiac contraction rate to 95 bt/min. in women and up to 90 bt/min in men, which is the same percentage (59) of the cardiac contraction rate with VO_{2max} .

In accordance with the proposed classification the production loads accompanied by energy outlays above 175 kcal/h with cardiac contraction rate over 90 bt/min should be classified in women with the III degree of heaviness, while the loads accompanied by energy outlays higher than 240 kcal/h with cardiac contraction rates over 100 bt/min--to the IV.

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TABLE 2
CRITERIA FOR PHYSIOLOGICAL EVALUATION OF LABOR LOAD FOR WOMEN

Degree of heaviness of labor	Energy outlays according to SN-245-71		% of energy outlays with VO_{2max} of men equal to 12.6 kcal/min	Energy outlays of women (corresponding % given in previous column of VO_{2max} of women equal to 8.8 kcal/min)		CCR		% of CCR with VO_{2max}	
	kcal/h	kcal/min		kcal/min	kcal/h	m	w	m	w
I (light)	to 150	to 3.5	19.8	to 1.7	to 110	to 80	to 80	50.0	53.0
II (average heaviness)	to 250	to 4.2	33.3	to 3.0	to 175	to 95	to 90	59.0	59.0
III (heavy)	to 350	to 5.8	46.5	to 4.0	to 240	to 110	to 100	69.0	66.0
IV (very heavy)	over 350	over 5.8	over 46.0	over 4.0	over 240	over 110	over 100	over 69.0	over 66.0

The question of the limitation of a certain class of work cannot be solved only on the basis of physiological shifts recorded in the period of work. It is necessary to compare the latter with the results of studies on the state of health, in particular, with the data on the specific functions of the female organism. There are as yet no published data on this. The results that we obtained in studying the group of female workers of four occupations demonstrate that the fulfillment of work of the II degree of heaviness (according to the suggested classification) does not have a negative effect on the state of health, while the fulfillment of work of the III and IV degree of heaviness induces an increase in the frequency of disorders in the menstrual cycle and genital function (A. N. Karakashyan).

If further studies confirm the conclusion on the more adverse effect of work of the III degree of heaviness on the state of health and specific functions, then the question of limiting a certain class of work for women can be solved as follows. Women are permitted to do work of the I and II degree of heaviness to a full measure, work of the III degree--with reduced working day or introduction of additional breaks, and it is expedient not to permit women to do work of the IV degree.

The use of a physiologically substantiated classification of the labor load on women will guarantee a scientifically substantiated approach to the organization and regulation of their labor and will promote preservation of health.

Conclusions

1. The fulfillment by women and men of the same type of loads under production conditions and dosed physical load 300 kgm/min is accompanied by greater stress of the physiological systems of the female organism--on the average by 15-17%.

2. The maximum aerobic capacity, energy outlays and amount of load (1818 ml/min, 8.8 kcal/min, 900 gkm/min) in women are 30% lower than the same indices in men (2620 ml/min, 12.6 kcal/min, 1300 kgm/min).

3. As a result of the studies physiological criteria were developed for evaluating the labor load on women based on the principle of the same (for women and men) degree of stress of the physiological functions with regard for the physiological cost of the shifts (energy outlays, pulse rate).

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